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Peach Production in Ohio

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OHIO
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CONTENTS

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PEACH PRODUCTION IN OHIO

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INTRODUCTION

This bulletin brings to the orchardists and prospective orchardists of Ohio information regarding the culture of peaches. It stresses the more practical aspects of the subject but includes reports of certain experiments and refers to others.

Peach growing in Ohio has experienced many vicissitudes since it became of commercial importance during the middle and latter part of the last century. San Jose scale, peach yellows, little peach, Oriental fruit moth, borers, cold winters, and periods of low prices have taken their tolls and shifted the industry from one section to another[2].

Notwithstanding these setbacks, peach production still retains a major place in Ohio fruit growing. Outstanding among the present trends which are likely to make a more permanent place for the fruit are the introduction of decidedly hardier and better-quality varieties, the increase in the marketing of the crop at the orchard or roadside stand, and the use of the truck to haul the fruit quickly to points over the State and into adjacent territory. To these should be added better selection of site and soil, which is discussed in this bulletin.

As these changes are made, the industry can be expected to become more stable, but adverse climatic factors will continue to discourage the grower. In the main, the peach should be planted only on favorable sites and to fit into a system of diversified fruit farming. In no section of the State should the peach be depended upon as the sole source of income.

THE INDUSTRY

The peach is one of the most important fruits grown in Ohio, ranking second to the apple. .Ohio produces about 2 to 3 per cent (2.44 per cent is the average for the last 27 years) of the peaches grown in the United States. This relative amount varies considerably, however.

Peach production in Ohio has declined somewhat since 1910, but there has been a slight increase in the number of nonbearing trees. Production data taken from United States Census reports are presented in Table 1.

TABLE 1.—Peach Production in Ohio

Census	Nonbearing trees	Bearing trees	Production
			Bu.
1910	2,092,300	3,133,368	1,036,340
1920	970,183	2,924,177	617,537
1930	1,461,539	2,356,404	478,395
1935	833,057	2,486,068	205,408*

*1934.

[1]The authors appreciate the cooperation of Mr. F. H. Beach, Extension Specialist, Ohio State University, in the preparation of this bulletin.

[2]The control of insects and diseases of the peach is given in Bulletin 562, which may be obtained by request from the Ohio Agricultural Experiment Station, Wooster, Ohio.

There has not been a heavy planting of peach in recent years, but there was some replanting in 1936, and indications are that there will be considerably more in 1937, especially in the southern part of the State, because of the widespread winterkilling during the winter of 1935-1936.

Peach sections are much more localized than apple sections in Ohio. The most important peach regions are Ottawa, Erie, Ashtabula, Lorain, and Lake Counties, along Lake Erie; Columbiana, Mahoning, Jefferson, Belmont, and Muskingum Counties, in eastern Ohio; and Lawrence County, in southern Ohio. In order of importance (based on both bearing and nonbearing trees) in 1935 (Census of 1935) are: Ottawa, Stark, Columbiana, Ashtabula, Wayne, Coshocton, Mahoning, Lake, Lawrence, and Tuscarawas Counties. Ottawa leads all the others in newly planted trees, with Stark second.

Ottawa County has long led all others in peach production, but in recent years there has been an increased planting of apple trees in that section. They have, to some extent, replaced peaches.

During the winter of 1935-1936 there was a widespread destruction of peach trees throughout most of the State. The region which escaped most notably was that along the Lake, particularly east of Cleveland, and extending for only a few miles from the Lake shore. This particular section suffered extensive injury in the winter of 1933-1934, but not to compare with that in other parts of the State as a result of the winter of 1935-1936.

Figure 1 shows the relationship between the price received for peaches in Ohio and that received for this fruit in the United States as a whole. It may be seen that with few exceptions, the Ohio prices are higher, but they vary considerably with the local production.

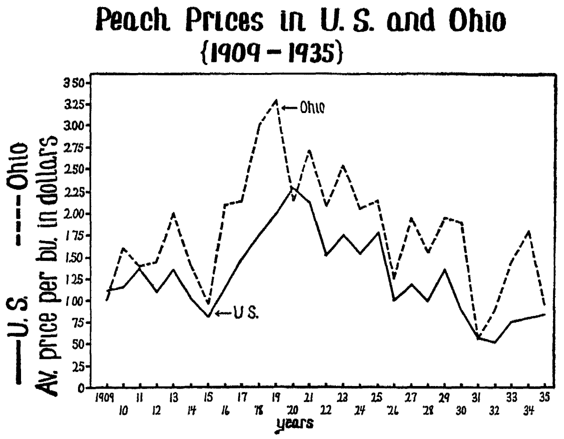

Fig. 1.—Relationship between the prices received for peaches in Ohio and in the United States as a whole (weighted averages)

Figure 2 clearly illustrates the relationship between the price received and the production of peaches in the State. It may be noted from this graph that the total yield of peaches in Ohio is extremely variable. Adverse climatic conditions are mainly responsible for the striking variation. Winter injury and late frost and drouth damage, as well as insects and diseases, are dangers which must be considered and avoided if possible. Peach growing in the southern half of Ohio has been particularly hazardous. Only by the best management can peaches be expected to be profitable there over a period of years. The chances of producing a good average yield of fruit each year are much greater along Lake Erie; however, winter injury occasionally occurs near the Lake, as in the winter of 1933-1934.

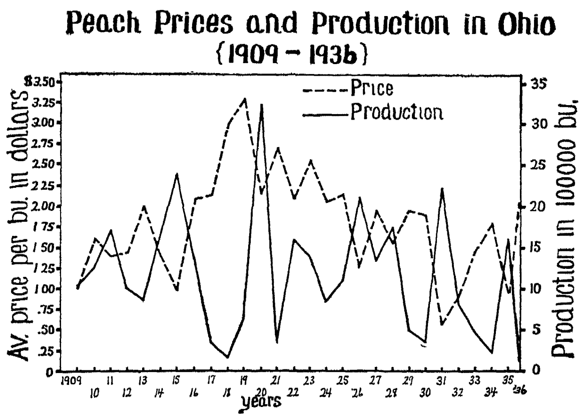

Fig. 2.—Relative variation of production and price of peaches in Ohio (weighted average). Note extreme variation, especially in production.

PROPAGATION

The average grower will find it preferable to purchase his peach trees directly from a reliable nursery rather than to propagate them himself. Nevertheless, a grower may find it desirable to propagate his own trees for some special purpose, such as to reproduce a new or particular variety.

PROPAGATION FROM SEEDS

Most of the seeds used in growing peach understocks are obtained from native peach trees of the Carolinas, Tennessee, and Kentucky. Sometimes the seeds for these stocks are secured from canning factories in other regions. Investigations (23) have shown that the "Carolina naturals" are preferable; they may be secured from several wholesale nurseries in the above-mentioned states, and frequently they are available in limited numbers at some of the more northern and eastern nurseries.

Probably one of the most satisfactory methods of treating peach seeds is to store them in damp peat moss, sand, or a mixture of the two in a cold storage at 35° to 40° F. during the winter. This has been one of the most successful methods tried at this Station. Sometimes the seeds are bedded or stratified outside in the fall in moist sand; this method is often convenient and satisfactory. Frequently the seeds are stored during the winter in pits; several nurseries use this method and find it quite satisfactory. It is not necessary that seeds freeze, as is often supposed. In the early spring following any of the winter treatments outlined, the seeds are planted in rows; a high percentage of germination can be expected.

The more common practice is to plant the seeds in the field during the fall at a depth of about 2 inches, in rows about 3 feet apart; there they germinate the following spring. Too much moisture, as prevails under conditions of poor drainage, will injure the seeds and cause poor germination. The method of germination used depends largely on the conditions under which the grower must work. Special precautions must sometimes be taken to avoid destruction of the seeds by rodents.

BUDDING

Peaches are usually propagated by budding rather than by grafting. In this State, budding is done largely during the latter part of July and in August. Occasionally it is done in June, but in Ohio June budding is rarely successful. The shield, or T-budding method, is used. Small seedling trees produced from seeds planted the previous fall (or spring, if they have been stratified or stored) are used. A T-shaped cut is made on the north side near the base of the seedling stock, and the shield-shaped bud is inserted into it. The bud is then kept firmly in position by wrapping with rubber bands or strips of raffia; rubber bands seem preferable. If raffia is used, it should be removed as soon as the bud has set. Early in the following spring, the stock should be removed just above the inserted bud. The budding procedure is given in detail in Bulletin 510 of this Station.

The young shoot which develops from the inserted bud is allowed to develop throughout the growing season after the budding. The young tree is set in its permanent location during the following spring—about 19 months after the insertion of the bud in August.

Most peach budding is done on peach stock, but plum and apricot stocks may be used. Since the plum is not attacked by nematodes, it is sometimes used as the understock on old land or land infested with nematodes. For Ohio conditions peach stock is preferable.

VARIETIES

At the present time there is a tendency to plant peach varieties which are earlier than Elberta. This has been brought about mainly because of the greater infestation of those later than Elberta by the Oriental fruit moth. Also, there is a good demand for early peaches in some sections of Ohio. The recent development of early varieties which are firmer and of higher quality than those previously grown has also encouraged greater use of the early ones. An effort is being made by fruit breeders to introduce varieties which are higher in quality and more hardy than the Elberta.

The variety or varieties chosen depend largely on marketing conditions. Where peaches are to be sold throughout the season a selection of several varieties with a succession of ripening dates should be made.

Following is a brief description of varieties which are recommended for commercial planting in Ohio. It is intended that this list be used as a guide only, since no list could be applicable to every Ohio grower. The varieties are listed according to the approximate order of ripening.

Golden Jubilee—attractive yellow freestone; medium to large size; shape similar to Elberta; quality superior to Elberta; above average in winter hardiness of wood and bud. Golden Jubilee is the earliest commercial yellow freestone for Ohio.

Carman—white; semifreestone; almost round; medium size; soft flesh; fair quality for eating fresh, but poor for canning; both fruit buds and wood very hardy to low winter temperatures; a productive variety.

Cumberland—white; almost entirely freestone; oval; medium to large size; firmer than Carman; good quality; hardy and productive. Because of its more uniform size, firmness, and quality, Cumberland is to some extent replacing Carman.

Rochester—yellow; freestone; round; medium size; fuzzy; firm; good quality; variable in production; very hardy; requires considerable pruning and thinning in order to secure large fruits. Rochester is valuable because of its hardiness, season, and quality.

South Haven—yellow; entirely freestone most seasons; medium to large size (variable); round; moderately firm; good quality; productive; fruit buds fairly hardy to low winter temperatures; wood relatively tender.

Champion—white; semifree to freestone; medium to large size; round; tender and juicy; outstandingly high quality; hardy enough to withstand most Ohio winters. Champion bruises easily; hence should be marketed directly.

Early Elberta—yellow; freestone; smaller and slightly more compressed than Elberta; fairly firm; quality better than Elberta; productive.

Belle of Georgia—white; freestone; medium size and oval shape; firmer than Champion though none too firm; high quality; productive and very hardy under most conditions; commonly grown and considered by many the choice of the white varieties.

Elberta—the most commonly grown and leading commercial peach; yellow; freestone; large size; roundish oblong shape; firm flesh; fair to poor quality; tender in bud. The tree is vigorous and productive and may be grown under a wide range of climatic and soil conditions.

In addition to the above commercial varieties, the following ones may be found valuable in extending the season or for special purposes:

Marigold—yellow; semicling; medium to small size; soft flesh; fair quality; moderately productive; fruit buds hardy to low winter temperatures; ripens about 2 weeks before Carman and Golden Jubilee; hence, may be of value as a very early variety.

Pioneer—white; freestone or nearly so; medium size; round; fairly firm for its season; good quality; productive; fruit buds very hardy. This variety is worthwhile in some plantings because of its earliness and hardiness.

Vedette—attractive yellow color; freestone; medium to large size; roundish shape; firm flesh; very high quality; hardy under most conditions; fairly productive. Tests by F. S. Howlett in 1937 showed nonviable pollen, indicating that this variety is self-unfruitful.

Valiant—yellow with red blush; freestone; medium to large size; fairly firm; very high quality; as hardy as Vedette; productive.

Eclipse—yellow; freestone; medium size; firm flesh; good quality; one of the hardiest varieties at the Station. This variety has not yet been tested extensively enough for recommendation as a commercial variety.

Shipper's Late Red (Big Red)—yellow; freestone; medium to large size; firm; good quality; productive; seems to be hardier in bud and higher colored than Elberta. This variety has been most profitable in Central and Southern Ohio.

J. H. Hale—yellow; freestone; very large but variable size; round; firm; high quality; often not productive; fruit buds, as well as wood, lack hardiness to low temperature; self-unfruitful. Many fruits often fail to develop; this results usually in a low yield of very large fruits. In the main this variety has been disappointing and new plantings of it have declined.

Hope Farm—white; freestone; medium size; oval; lacks firmness; good quality; productive; fairly hardy. It blooms slightly later than most other varieties. Tests by F. S. Howlett in 1937 showed nonviable pollen, indicating that this variety is self-unfruitful.

Wilma—yellow; freestone; medium to large size; Elberta type; firm; fair quality; productive; both buds and wood tender; apparently should be limited to planting in Lake region.

Williams Cling—yellow; clingstone; medium size; firm; fair quality; one of the leading clingstone peaches in Ohio, the demand for which is limited.

Lemon Free—yellow; fuzzy; freestone; medium in size; firm; good quality, especially for canning; ripens unevenly; only fair in production; more hardy than Elberta and Hale.

Salberta—yellow; freestone or nearly so; medium to large size; firm; fair quality; productive; lacking somewhat in hardiness of bud; preferred by many for a late variety.

Krummel—yellow; freestone; medium to large; very late.

At the present time we are uncertain as to the value of the following varieties in Ohio owing, in most cases, to a lack of sufficient or extensive tests. No attempt is made here to list them in order of ripening dates or relative importance.

Candoka—firm; dark yellow; freestone; ripens with Hale; almost fuzzless; very large; flavor and texture good; probably a good shipping variety.

Hardee—yellow; freestone; Elberta type; medium-sized fruit, longer and more compressed than Elberta; ripens toward end of Elberta season. This variety is hardier than Elberta in both wood and bud, which makes it one of the promising of the newer varieties.

Veteran—yellow freestone; very similar to Vedette, except that in some years it tends to cling slightly; slightly later than Vedette and Valiant.

Oriole—yellow; freestone; tender flesh; ripens about a week before Rochester. This is a good-quality peach which is promising for Ohio.

Sun-Glo—yellow; freestone; ripens with South Haven, or about 2 weeks before Elberta. Sun-Glo closely resembles the original strain of South Haven and apparently is about the same in hardiness.

Halehaven—a promising new yellow freestone; ripens with South Haven; more attractive color and thicker skin than South Haven; said always to be a freestone; apparently about the same in hardiness and quality as South Haven.

Fertile Hale—a new variety which is more vigorous than J. H. Hale and is self-fertile; ripens a few days later and is apparently more hardy than Hale. It is worthy of trial.

Hal-Berta Giant—large yellow freestone; resembles J. H. Hale in firmness and flavor; ripens slightly later than Hale. This peach has not yet fruited at the Experiment Station.

Welcome—yellow-fleshed; freestone; resembles Hale; said to be hardy and to bear well; has not been widely tested.

Rio-Oso-Gem—large yellow freestone; ripens with Elberta or slightly later; more nearly the size and shape of J. H. Hale; high quality; good shipper.

Kette—a new yellow, round, slightly oblong peach with very little fuzz; said to be an exceptionally good canning peach; ripens just after Elberta.

Maxwell—white; semicling; round; medium size; attractive color; good quality.

Polly—white; round; very hardy; freestone Champion type; probably useful only for local market and home orchard.

Gage Elberta—yellow freestone; large; better quality than Elberta; about same as Elberta in hardiness of fruit bud, but more hardy in wood; tree smaller and more spreading than Elberta; said to be resistant to bacterial spot; ripens with Elberta.

Delicious—white; freestone; resembles Belle; ripens just before Carman; has not been extensively tested.

NECTARINE VARIETIES

The outstanding difference between peaches and nectarines is the lack of fuzz on the fruit of the latter. Though they may prove valuable for the home orchard, roadside stand, or for special markets, the commercial value of nectarines in Ohio is limited. The best varieties from the standpoint of size and quality are not hardy enough for this State. Following is a brief description of a few which seem of most value here:

Goldmine—white flesh; semifreestone; round; medium to small size; soft; sweet.

Hunter—yellow; freestone; tart but pleasing flavor; medium to small size.

Sure Crop—white; freestone; desirable quality; round or nearly so; medium size. It seems above average in hardiness.

Quetta—white flesh; clingstone; almost round shaped; attractive color; large size for nectarine.

SIZE AND COLOR OF BLOSSOMS

It is often desirable to know the size and color of blossoms of peach varieties. Some varieties have such large, showy blossoms that they are used for ornamental purposes as well as for their fruit. A knowledge of the size of blossoms is also sometimes valuable in distinguishing between varieties. A classification of size and color of blossoms of several varieties, including some of the newer ones, is given below.

PEACH VARIETIES HAVING LARGE PINK BLOSSOMS

Alton	Goldmine (nectarine)	Morrow
Bilyeus	Greensboro	Radiance
Buttercup	Hardee	Rochester
Carman	Hunter (nectarine)	Salwey
Cumberland	Krummel	Sure Crop (nectarine)
Early Elberta	Lemon Free	Vedette
Eclipse	Marigold	Veteran
Florence	Maxwell	Wilma

The Heath Cling has small, pink blossoms.

PEACH VARIETIES WITH MEDIUM TO SMALL REDDISH BLOSSOMS

Banner	Gary	Licking
Beer's Smock	Golden Jubilee	New Prolific
Belle of Georgia	Gold Finch	Oldmixon Free
Big Red	Hal-Berta Giant	Oriole
Brackett	J. H. Hale	Pioneer
Candoka	Halehaven	Primrose
Champion	Harpole	Pure Gold
Downing	Heidelberg	Salberta
Elberta	Hope Farm	Shipper
Fertile Hale	July Gold	South Haven
Fitzgerald	Kalamazoo	Valiant
Gage Elberta	Kette	Victory

SECURING AND CARING FOR THE YOUNG TREES

There are advantages in securing trees from a nearby nursery. The cost of transportation of the trees is less, and the trees are less likely to be injured than those shipped great distances. It should be clear, however, that other factors, such as price of trees or desire for special varieties, may make it preferable to secure trees from a distance.

Most nurserymen are now making a special effort to distribute true-to-name trees. There will probably be even more improvement within the next few years. Methods of identifying varieties by their leaf and other plant characteristics have been investigated and are being used successfully. Moreover, nurseries are more than ever making it a point to secure their budding stock from bearing trees of known performance, and are taking special precautions in the handling of the bud sticks and young trees.

The fruit grower should secure peach trees which are mature, 1 year old, vigorous, and free from disease. The root system should be well developed. Young trees 4 to 5 feet in height and 7/16 to 9/16 inch in diameter are most satisfactory. Trees are sometimes sold according to height and sometimes, according to diameter.

Although planting should be done in the spring in most parts of the State, it may be preferable to secure the trees in the fall or winter. Trees should be set in the permanent location just as early as the soil can be prepared in the spring, usually during March or early April.

HEELING IN

If it is at all convenient, young trees should be set in their permanent locations as soon as they arrive from the nursery. Often, however, planting must be delayed for a few days at least. If the trees are not planted at once, they should be unpacked and heeled in. This is done by digging a trench and placing the roots in it, inclining the tree to an angle of about 45 degrees toward the east or south. The bundles in which trees are usually received should be opened so that the roots may be spread out well. The soil in which the plants are heeled in ought to be well drained. After the trees are placed in the trench, soil is placed over the roots and worked down among them. It should cover the roots and the lower portion of the trunk. This soil should be kept moist but not wet.

TABLE 2.—Peach Varieties with Approximate Ripening Dates and Yields at Wooster, Ohio

(No crop in 1936 because of previous severe winter)

Variety	Color	Year planted	Approximate ripening dates*	Yield per tree				
				1931	1932†	1933‡	1934‡	1935
				Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Mayflower	White	‖	July 15	......	......	......	......	......
Mikado§ (June Elberta)	Yellow	1935	30	......	......	......	......	......
Buttercup	Yellow	1927	August 2	3.2	2.0	1.3	2.3	3.3
Marigold	Yellow	1927	4	1.0	1.7	1.8	0.3	5.5
Greensboro	White	‖	6	......	......	......	......	......
Arp	Yellow	‖	10	......	......	......	......	......
Pioneer	White	1924	12	5.5	6.5	3.5	5.5	5.7
Gold Finch	Yellow	1932	14	......	......	......	......	0.2
Cumberland	Yellow	1927	14	1.0	5.0	0.3	2.5	10.3
Golden Jubilee	Yellow	1927	15	2.8	3.8	0.2	0	6.0
Carman	White	1926	17	7.0	5.8	6.5	0	11.0
Radiance	White	1927	18	2.0	4.5	1.8	3.3	8.5
Rochester	Yellow	1932	20	......	......	......	......	0.3
Vedette	Yellow	1929	24	0.2	0.8	1.0	0.2	4.0
Valiant	Yellow	1929	30	0.8	1.3	0.2	0	5.5
Halehaven§	Yellow	1934	25	......	......	......	......	......
South Haven	Yellow	1924	25	4.5	5.0	2.7	1.0	7.5
Sun-Glo§	Yellow	1935	25	......	......	......	......	......
Hiley	White	‖	30	......	......	......	......	......
Slappey	Yellow	‖	30	......	......	......	......	......
Captain Ede	Yellow	‖	September 1	......	......	......	......	......
Veteran	Yellow	1929	1	2.0	2.0	0.2	0.2	5.5
Eclipse	Yellow	1927	2	1.5	3.3	0.3	3.4	5.0
Engle	Yellow	‖	3	......	......	......	......	......
Champion	White	1926	3	2.0	3.2	3.1	1.0	6.5
Early Crawford	Yellow	‖	5	......	......	......	......	......
Early Elberta	Yellow	1923	5	8.6	6.8	0	0	9.3
New Prolific	Yellow	1923	6	7.1	5.3	3.5	0	7.5
Primrose	Yellow	1924	6	1.5	5.5	0	4.5	7.1
Heidelberg	Yellow	1923	6	......	6.4	3.6	0	7.4
Niagara	Yellow	‖	7	......	......	......	......	......
Belle of Georgia	White	1933	7	......	......	......	......	1.0
Fitzgerald	Yellow	1923	8	3.5	2.3	1.0	0	8.0
Maxwell	White	1931	8	......	......	......	0	5.3
Big Red	Yellow	1927	9	......	5.0	0	0	7.5
Candoka§	Yellow	1933	9	......	......	......	......	......
J. H. Hale	Yellow	1923	9	6.5	1.3	0.2	0	8.0
Welcome§	Yellow	1935	9	......	......	......	......	......
Fertile Hale§	Yellow	1934	10	......	......	......	......	......
Elberta	Yellow	1924	10	6.4	5.3	0	0	9.5
Gage Elberta	Yellow	1930	11	......	......	0	0	5.0
Rio-Oso-Gem§	Yellow	1935	11	......	......	......	......	......
Gary	Yellow	1924	12	......	......	0	0	6.5
Kette§	Yellow	1934	14	......	......	......	......	......
Hardee	Yellow	1927	14	......	2.5	......	3.0	4.6
Oldmixon	White	1923	10	8.0	4.9	1.0	0	6.0
Morrow	Yellow	1931	12	......	......	0.5	0	4.5
Hope Farm	White	1927	14	2.5	4.1	5.5	0	9.8
Wilma	Yellow	1926	15	7.0	3.8	0	0	5.5
Late Crawford	Yellow	‖	16	......	......	......	......	......
Kalamazoo	Yellow	1923	16	8.0	3.7	2.5	0	7.1
Crosby	Yellow	‖	16	......	......	......	......	......
Gold Drop	Yellow	‖	22	......	......	......	......	......
Williams Cling	Yellow	‖	23	......	......	......	......	......
Banner	Yellow	1923	23	7.7	3.8	3.5	0	6.5
Lemon Free	Yellow	1923	25	4.1	4.0	4.0	0	7.2
Salberta	Yellow	1923	27	10.3	4.0	0.5	0	12.0
Smock	Yellow	1923	October 1	6.5	5.3	1.0	......	6.0
Heath Cling	White	1923	12	11.2	5.0	0.5	0	6.0
Salwey	Yellow	‖	18	......	......	......	......	......
Krummel	Yellow	‖	25	......	......	......	......	......

*Variable.
†A late spring frost destroyed many fruit buds.
‡Minimum temperature of winter of 1932-1933 was —10° F., of 1933-1934, —15° F.
§Has not yet fruited at the Ohio Experiment Station.
‖Not growing at Wooster now.

PLANTING THE ORCHARD

Land to be used for peaches should be thoroughly plowed and disked before the trees are set out. Some variation from this may be found necessary in individual cases. As mentioned previously, it is important that the trees be planted as early in the spring as possible. They should be set 20 to 25 feet apart, depending somewhat on the native fertility of the soil. In poorer soils the trees may be set closer than in soils which are more fertile. Close planting is usually regretted within a few years. The square system is commonly used in planting peaches. Obviously, it is an advantage in such practices as spraying and cultivating to have the trees in straight rows.

The hole in which the tree is to be set must be large enough to accommodate the roots without crowding. If there are any broken or injured roots, they are removed. As the hole is filled, the soil should be firmed well around the roots. It is preferable to set the tree 2 or 3 inches deeper in its permanent location than it was in the nursery. Deep planting, however, is detrimental and is the cause of the loss of many trees. On land where there is danger of standing water trees may well be planted on slight ridges.

During the process of planting, the roots of the young trees should never be allowed to dry out. They can be kept moist by hauling the trees in a tub or barrel of water or by keeping wet burlap over the roots at all times.

Soon after the tree is set in the orchard it is pruned. Pruning is described later in this bulletin.

Almost all peach varieties are self-fruitful; the J. H. Hale and Mikado (June Elberta) are notable exceptions. Hence (in striking contrast to apples) the problem of arranging varieties in the planting in order to secure satisfactory cross-pollination does not usually arise.

The practice of using peaches as fillers in apple orchards is often followed in order to secure an income from the orchard before the apples are in full production. The spraying schedule is usually quite different in peach and apple orchards but in recent years some growers in certain sections of Ohio have been able to use the same spray formulas for both peaches and apples; therefore the spraying factor may not be as important in this connection as it was considered a few years ago. Often, however, peaches are not well suited to localities where apples grow well. Apparently, also, apples may be grown in sod more successfully than peaches; hence a different cultural treatment is often desired for the two fruits. Furthermore, there is the tendency of growers to leave peach trees in the apple orchard too long for best growth and production of the apples. Although some growers have done it successfully, it is usually not advisable to use peaches as fillers.

THE SELECTION OF THE SOIL AND THE SITE

The peach grower's first consideration is that of the site for the orchard. Location factors, such as elevation, soil, drainage, relation to bodies of water, and proximity to windbreaks or woodland areas, must be considered. Availability of water for spraying and possible irrigation is important also.

THE SOIL

No one type of soil is essential for peach culture, but long experience has shown that a soil which is deep and naturally well drained is best. A soil in which the roots can be well distributed to a depth of from 3 to 5 feet will produce trees that are more reliable as to length of life, regular bearing, and ability to withstand such adverse conditions as drouth, excessive rainfall, and low temperatures than one which is shallow (18 inches to 2 feet). There are some exceptions to this, particularly where trees are planted over ledges of stone and the roots penetrate into crevices of the rocks. In most Ohio soils, most of the root system is within the surface 2 feet, but in deep soils there are many roots extending to a much greater depth.

The suitability of a soil for orcharding may be determined in part by its color and the absence of a hardpan, or impervious layer, in the subsoil. A brownish or reddish color indicates good drainage and sufficient air for root activity. If the soil is bluish or gray, or if it is mottled in color, it has poor drainage and is unfavorable for root growth. In a publication from this Station (5), the soils of Ohio which are favorable to orcharding are listed; this may be used as a guide in the selection of soils for peaches. The color of surface and subsoils is indicated, together with general topography and natural drainage. This circular, together with the Generalized Soil Map of Ohio, should be consulted.

ELEVATION

Peaches planted at low elevations, regardless of soil type, are as a rule more susceptible to destruction from spring frosts and the low temperatures of winter than are those on high land. The actual elevation above sea level is not so important as the elevation above the immediately surrounding country. Differences in elevation which seem comparatively slight may be sufficient to make the higher land more profitable for peaches. This is not always true, however, for nearness to bodies of water or strong air currents may offset the matter of elevation sufficiently to make such a site particularly favorable.

LAND AND SOIL DRAINAGE

A distinction must be made between surface drainage of the land and drainage of the soil. A gentle slope is usually sufficient to allow the excess surface water to drain from the land and prevent standing water. Excessive slopes, even though the elevation be ideal, are a hazard from the standpoint of soil erosion and make orchard operations more difficult and expensive.

Soil drainage refers to the free movement of excess water through the soil. This is an important factor in the aeration and penetration of nutrients through the soil. A waterlogged or saturated soil results in stunted trees and often, in the gradual death of the roots. The presence of excessive water for even a comparatively short time at critical periods of the year may have serious consequences.

In poorly drained soils, a system of tile drains should be installed. The main lines usually follow the main depressions, and laterals extend into the minor depressions. In a heavy soil the lines should be placed 18 inches to 2 feet deep; in a lighter one they may be at 30 inches.

PROXIMITY TO BODIES OF WATER

Unless the area of water is extensive there is little or nothing gained by planting a peach orchard near it. Where the water area is extensive, as is Lake Erie, considerable advantage is gained, but the Lake is no guarantee of safety. This influence usually extends 3 to 5 miles, occasionally, as far as 10 miles. Water gives off heat during the winter and early spring when the earth is cold or frozen, but it warms up more slowly than the land with the return of spring and thus contributes to the prevention of early blossoming. Such a moderating effect of temperature both in winter and spring favors fruit growing, providing other influences are satisfactory.

WINDBREAKS

It has been customary in many quarters to plant a windbreak on the windward side of an orchard for protection. Frequently, windbreaks are too close to the trees and cause more damage than they prevent. When the wind passes over a windbreak it leaves an area of still air on the leeward side for some distance from the windbreak. It is in this area that the greatest frost or freezing damage is done. This has been noticed with grapes, strawberries, peaches, and apples, in fact, with all fruit crops. The same is true where a piece of woodland serves as a windbreak. Even if the wood lot is on the leeward side of an orchard, particularly at the bottom of a slope, the cold air drains into this pocket and is held there, resulting in more damage to fruit trees there than elsewhere in the orchard.

A windbreak may also result in serious shade and competition for soil moisture and nutrients.

If such woodlots or windbreaks exist, it is necessary to decide whether the orchard or forest trees are of prime importance. In some localities windbreaks are desirable, and gaps or openings are made in them for air drainage.

ACCESSIBILITY OF WATER

In selecting an orchard site a careful survey should always be made of the water supply. Great economies can be effected by having a short haul for the sprayer; if the water supply is not centrally located, tanks into which water may be pumped can be provided at well-located stations in the orchard.

Where sufficient water is available and the contour of the land permits it, irrigation during dry seasons is likely to become more prevalent. Size of fruit and condition of trees can both be improved by additional water in some seasons.

THE MANAGEMENT OF THE ORCHARD

Many operations, such as tillage, use of fertilizers and green manure crops, pruning, spraying, thinning, harvesting, and selling the crop, are involved in orchard management. Undue emphasis should not be placed on one practice to the exclusion of others; there should be such an interrelation of practices as will give the most economic production of the crop. Management practices have been treated separately, but only for the convenience of the reader and not because they should be thought of as separate and unrelated operations.

ORCHARD CULTURE

The peach is more frequently cultivated throughout its life than is any other tree fruit grown in Ohio. There are productive orchards in the State, however, which are grown in alfalfa sod, mulch, or even a nonlegume sod, but this is not common. The peach responds particularly well to tillage and frequently does poorly in sod although the trend is toward less cultivation.

After a well-drained soil, well supplied with native organic matter, has been selected, it is desirable to plant it to some tilled crop, such as potatoes, corn, or garden crops, for at least a year before planting to peaches. The well-prepared land is then set to trees in the fall or spring (depending upon geographical location) and cultivated the forepart of the season. In the past the practice has been to cultivate the land until about August 1, when a cover crop was sown. There is a trend at present to cultivate for a shorter period and secure two cover crops a year. The first crop is sown about June 1 if there is sufficient moisture in the soil, and is disked in about mid-August. A second crop is then sown; it is allowed to remain on the land until spring. Under this program the land is tilled for only about a month (about two cultivations) and then seeded. With this treatment more organic matter is turned into the land, and less erosion can take place.

THE COVER CROPS

There is probably no best cover crop for all conditions. The chief consideration is that of securing an ample rather than a meager growth, so that more organic matter will be incorporated with the soil to offset the loss resulting from stirring the land. A second is that of moisture relations. If the crop grown is a serious competitor with the trees for water, it is undesirable except in wet years.

For the early part of the season soybeans have long been considered a valuable crop. They should be sown about June 1 and disked down about August 15 to September 1. Cowpeas may be substituted for soybeans in the southern part of the State and on poor land. In order to secure maximum crops, acid soils should be limed, and all the land area should be fertilized.

For a late summer crop hairy vetch, or vetch and rye or wheat sown together at the rate of about 18 pounds of vetch and a bushel of either of the latter, form a good ground cover for the winter. In the southern part of the State crimson clover, at the rate of 15 pounds per acre, may be substituted for the vetch.

Sweet clover is frequently used as a cover crop, but it is best used while the trees are young, since it draws heavily upon the soil moisture. It can be sown in the spring or in August. Sweet clover seed should be inoculated, and land on which it is planted should be limed if it is acid (below pH 6.0). Although it makes considerable tonnage and adds a large amount of nitrogen to the soil, sweet clover should be avoided except where soil moisture is abundant or irrigation is practiced, as it is a serious competitor for soil water.

Korean lespedeza forms a good cover for orchards on the hill lands of southern Ohio, where little permanent grass is maintained. It is, like sweet clover, exhaustive of soil moisture, although its root system is not so extensive. It should be seeded at the rate of 18 pounds to the acre in March or April.

PERMANENT COVERS

Although the peach responds best to tillage, there is advantage in having the orchard seeded down to a permanent or semipermanent cover where there is danger of erosion. A legume sod or even a bluegrass sod may be used for this purpose. Trees grown in permanent covers should be mulched, preferably with a legume hay, or the area near the trees should be torn up to some extent each spring; a weed hog or cultivator of some type can be used for this purpose. This system avoids the objectionable features of a typical bluegrass sod and has some of the advantages of cultivation.

ROOT DISTRIBUTION STUDIES

Elberta peach trees 10 to 12 years of age were used in studying peach root systems to obtain information on the distribution, depth, relative number, and size of the roots at Wooster. The studies were made in several types of soil, namely, Wooster, Canfield, Volusia, and Trumbull silt loams. These four types are known as the Wooster group.

METHODS USED

Various types of trenches were used; that found most satisfactory was one from the base of the tree outward either directly along the tree row or at an angle of 90 degrees with it (Fig. 3). The trench was made 2½ feet wide, 9 feet long, and as deep as any roots were found. One side of the trench was

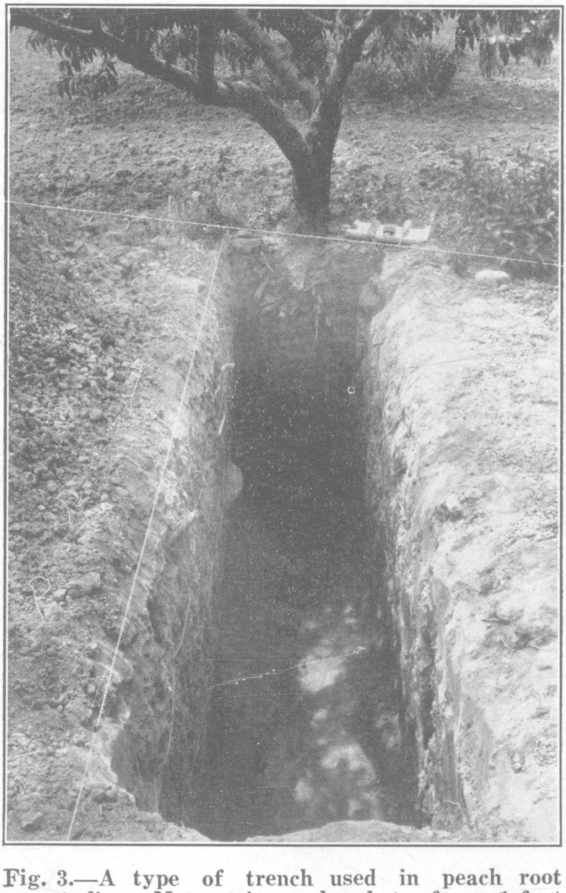

Fig. 3.—A type of trench used in peach root studies. Note strings placed to form 1-foot squares at left side of trench. The roots were mapped directly from this.

marked into foot squares, according to the method of Beckenbach and Gourley (4). The root counts and diameters were recorded directly on graph paper; the roots were then mapped to scale on large cardboards and photographed. With the aid of the Soils Department the soil profile in each trench was outlined.

WOOSTER SILT LOAM

Of the four soil types included in the Wooster group, the Wooster silt loam is the most satisfactory for orchards. It is deep, fertile, and well drained, both in the surface and subsoil. From the surface to the depth indicated by Line A in Figure 4 was the extent of the soil usually cultivated. The soil between Lines A and B was little different in character and composition, but was brownish-yellow in color and lower in organic matter. A slightly heavier soil was found between B and C. It was hardly as well drained as that above and was yellowish-brown in color. The parent material, composed of sandstone and shale, was located at a depth of 26 to 32 inches (Line C, Fig. 4).

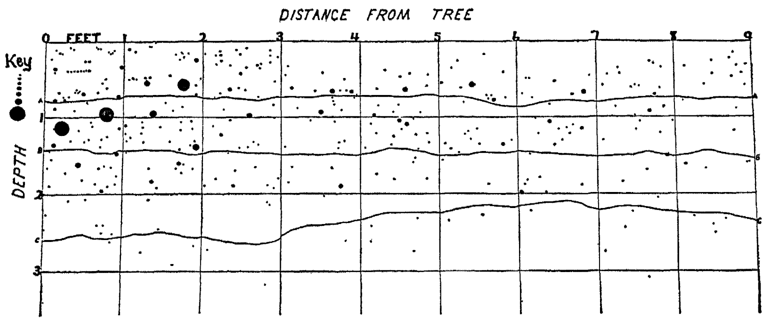

Fig. 4.—Peach root distribution in Wooster silt loam soil
Key to root diameters: (top to bottom) 0-1 mm.; 2-3 mm.; 4-5 mm.; 6-10 mm.; 11-20 mm.; 21-30 mm.; 31-40 mm.; and 41 mm. or over

It may be noted from Figure 4 that the roots were well distributed in this soil type. However, the parent material (sandstone and shale) was relatively close to the surface; and therefore almost 60 per cent of the roots was in the first foot of soil and about 90 per cent, in the first 2 feet. Very few of the roots penetrated the sandstone and shale (Line C, Fig. 4), probably because this material was relatively compact at this particular location.

CANFIELD SILT LOAM

The Canfield silt loam was hardly as well drained, either in the surface or subsoil, as the Wooster silt loam. The soil horizons were very similar to those found in the Wooster silt loam, but the region indicated between Lines B and C (Fig. 4) was, in the Canfield, composed of more compact and poorly drained soil than in the Wooster silt loam. The roots apparently penetrated this slightly mottled yellowish-brown soil very well, however. The sandstone and shale layer was found at about the same depth as in the Wooster soil and was rather compact; hence the roots failed to grow deeper. There was relatively little difference in the general distribution of roots in the Canfield and Wooster silt loams under the conditions of the observations.

VOLUSIA SILT LOAM

The Volusia soil was not as well drained as the two previously described. The surface soil was light brown to brownish-gray in color. At about 8 inches there was a distinct change to a more gray soil. A larger percentage of the roots was found in the first foot of soil in this type than in the Wooster or Canfield. Since the subsoil was heavier than the soil above and mottled with brownish-yellow, there were relatively few roots above 2 mm. in diameter there. These roots were found to penetrate the shale and sandstone located at about 35 inches. Peach trees in this soil type have been relatively vigorous and productive.

TRUMBULL SILT LOAM

Peach trees (12 years of age) in the Trumbull soil here described had been injured more severely during the winter of 1935-1936 than those in the Volusia nearby. As in the other soils, however, none of the roots seemed to have been injured.

As shown in Figure 5, a large proportion of the roots was within the first foot of soil. The soil above Line A (Fig. 5) was gray to grayish-brown in color and relatively loose. The soil between Lines A and B was gray to mottled gray in color and much lower in organic matter than that above. Roots were found in this soil but they were not as numerous as those found above it. At about 16 inches (Line B, Fig. 5) a very compact soil was found. It was mottled with yellowish-brown and was extremely heavy. The roots here were all small and located largely in the crevices or gray strips in the

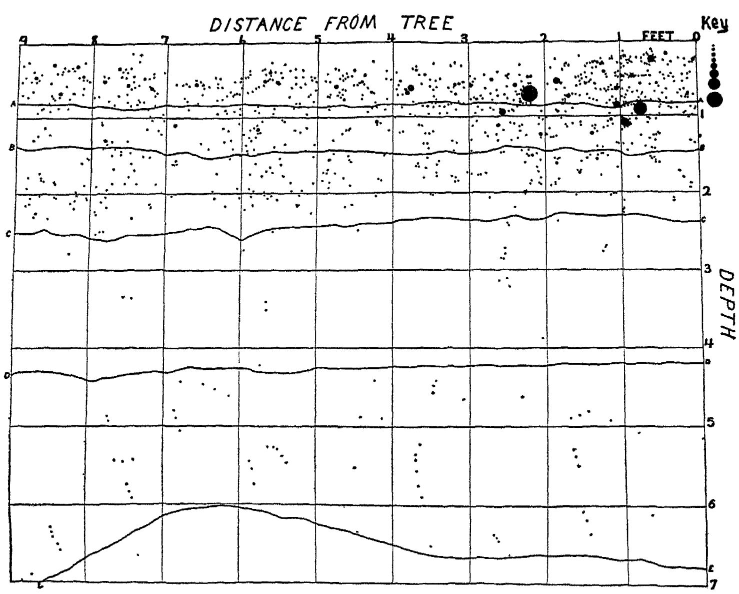

Fig. 5.—Peach root distribution in Trumbull silt loam
Key to root diameters: (top to bottom) 0-1 mm.; 2-3 mm.; 4-5 mm.; 6-10 mm.; 11-20 mm.; 21-30 mm.; 31-40 mm.; and 41 mm. or over

soil. The region between Lines C and D (Fig. 5) was parent material composed of considerable sandstone and some shale. The soil here was mottled between the sandstones, and there were occasional pockets of clay. The few roots found were located almost entirely in the clay and seemed to follow it downward.

At about 50 to 52 inches (Line D, Fig. 5), there was a change from sandstone and shale to a layer of compact silt and sand. In this soil there were concretions of gray clay in which there were usually small roots. Although all were relatively small, the roots were more numerous here than in the sandstone and shale layer above. At the depth represented by Line E in Figure 5, a soil composed of very coarse sand and sandstones was found; no roots were found there.

The depth of the Trumbull silt loam described here is somewhat unusual. For that reason, even though a few roots were located at 83 inches, it should not be inferred that all Trumbull soils are alike in depth of glaciated material. It should be emphasized that an extremely high proportion of the roots was near the surface in this soil type.

FERTILIZERS FOR THE PEACH ORCHARD

No definite fertilizer recommendation can be made for all peach orchards. Much depends on the type of soil, native fertility of the land, and age and condition of the trees. Ordinarily, sulfate of ammonia, nitrate of soda, or Cyanamid is used each year in early spring or autumn at the rate of ¼ to ⅓ pound per year of age of the trees. The fertilizer is usually sown by hand under the branches and somewhat farther out. Some orchardists apply fertilizer over the entire orchard area.

Superphosphate and muriate or sulfate of potash are sometimes necessary to obtain a satisfactory growth of cover crops. Superphosphate is used at the rate of 300 to 500 pounds per acre, broadcast over the entire orchard area. Either muriate or sulfate of potash may be used at the rate of 100 to 200 pounds per acre. Both phosphate and potash are applied either in early spring or just before the cover crops are sown.

Definite experimental results on the fertilization of peach trees have been somewhat limited. This is especially true for trees grown in soils similar to those found in northern Ohio. Several years ago some fertilizer investigations were carried on by this Station in that region. As they have not been published previously, except in a very much abbreviated form, they are included in this general report on peach growing. They are in keeping with subsequent experience.

PLAN OF EXPERIMENT[3]

This fertilizer experiment was conducted in an orchard at Danbury, Ottawa County, Ohio.[4] The orchard was 9 years old and had received good care. It was located practically on the shore of Sandusky Bay, an inlet of Lake Erie. The soil was Randolph silt loam and silty loam underlaid by limestone at a depth varying from 30 to 40 inches, and would be considered of rather poor native fertility. The soil reaction varied from slightly acid to slightly alka-

[3]This material was partially compiled and used as a portion of a Master's thesis by Harold Robertson at the Ohio State University in 1933.

[4]The writers appreciate the cordial cooperation of Mr. W. C. Yule during these experiments.

line, from pH 5.9 to pH 7.7, in the four plots where samples were taken. The experimental block chosen consisted of 11 rows of 10 trees each and was bordered on all sides by similar trees. The trees were planted 18 feet by 18 feet; this gives about 134 trees per acre. Elberta was used for this investigation because it is the most important variety in Ohio and because there are probably more trees of the Elberta variety than any other planted in the United States.

Data were taken on twig growth, increase in trunk circumference, appearance of foliage, formation of fruit buds, susceptibility to frost injury, yield, date of ripening, size of fruit, and keeping quality, in an attempt to determine the effect of each treatment.

The 11 plots were laid out with the expectation of determining the following:

1. Comparative values of nitrate of soda and sulfate of ammonia as carriers of nitrogen.
2. The value of divided or split applications of nitrate of soda and sulfate of ammonia as compared with a single, unit treatment in April.
3. The effect of adding phosphorus and potassium to the nitrogen.
4. The value of organic versus inorganic carriers of nitrogen.

METHOD OF APPLICATION

The fertilizers used in these experiments were all applied by hand. An effort was made to secure an even distribution on the entire area extending from a foot or so from the trunk to just a little beyond the drip of the branches.

RATE OF APPLICATION

The amount of fertilizer applied to each tree was 3 pounds of sulfate of ammonia or its equivalent, as indicated in Table 3. The amount of nitrogen applied was kept constant except in one case, Plot 4, on which one-third more ammonium sulfate was used. On the basis of 134 trees per acre, the amounts of the various fertilizer materials used in the experiment were: 400 pounds of sulfate of ammonia, 500 pounds of nitrate of soda, 600 pounds of nitrate of potash, 600 pounds of acid phosphate, 150 pounds of muriate of potash, 950 pounds of tankage, and 650 pounds of bone meal per acre. In most of the plots the actual nitrogen applied amounted to about 82 pounds per acre.

VALUE OF NITROGENOUS FERTILIZERS

Despite the widespread knowledge of the value of nitrogen in the stimulation of tree growth and its favorable effect in increasing the set of the blossoms, particularly if the soil is naturally lacking in soil nitrates, some peach growers were prejudiced against its use. In the section where these experiments were conducted there was a disposition to prune heavily as a means of balancing the tree with an infertile soil rather than improve the soil by means of ample manure, fertilizers, and cover crops. Not all orchards of that section were so treated, nor were all the soils infertile, but it is clear that the trees on most of the land will respond to treatments of nitrogen unless the soil is very poorly drained or the roots and tops of the trees are seriously devitalized. Heavy pruning is a poor substitute for manure or fertilizers, not only because it devitalizes the tree, but also because it decreases the bearing surface on which future crops could be borne if supplied with the proper fertilizer materials.

EXPERIMENTAL RESULTS

NITRATE OF SODA VERSUS SULFATE OF AMMONIA

Orchardists who have long since realized the value of nitrogen have not been satisfied as to the cheapest and most efficient form in which to purchase it. The two most common commercial sources at the time this work was inaugurated were nitrate of soda and sulfate of ammonia, the former carrying 16 per cent of nitrogen (19.5 per cent NH_3) and the latter, 20.5 per cent of nitrogen (25 per cent NH_3). Nitrate of soda was used almost exclusively by the early investigators; hence, it was more commonly used in orchards at first.

Certain prejudices, based largely upon the findings of agronomists in their experiments with field crops and pot cultures, existed regarding the use of sulfate of ammonia. The chief objections were that it resulted in an increase in soil acidity, that it was slowly available, and that it failed to give as great a return as an equal amount of nitrogen in the nitrate form. Trees are much more difficult subjects for measuring the value of fertilizing materials, but the evidence, to date, would indicate that there is little if any difference in the value of these two materials in the orchard, provided the soil reaction is favorable (pH 5.5 or above).

As previously stated, the acidity of this soil ranged from pH 5.9 to pH 7.7 on the plots tested. This fact is significant when the relative values of nitrate and ammonia nitrogen are considered in the light of the results obtained by Tiedjens and Robbins (22). In general, nitrate nitrogen and ammonia nitrogen are absorbed at any pH, but the former gave the best results (response in growth) at pH 4.0 to pH 5.0 and the latter, at pH 7.0 and above. The growth response is an indication that the nitrogen absorbed is being utilized by the plant. In any comparison of sulfate of ammonia and nitrate of soda it must be borne in mind that continuous applications of the former tend to make the soil more acid or of a lower pH value. This may account for the fact that continued use of sulfate on the same soil may fail to give the same effect year after year. In order to correct this, the addition of lime (about 1 ton of limestone to a ton of sulfate of ammonia) is necessary. The cost of the lime must be added to the original cost of the sulfate of ammonia in order to have the comparison valid.

Table 3 gives a brief composite summary of the entire experiment.

GROWTH OF TREES AND YIELD

Since the orchardist has come to associate general vigor and productiveness with the amount and kind of growth extension that trees make, they are discussed together. Although this index ignores the diameter of the shoots, which is important, it is satisfactory in the main and is substantiated by most investigators reporting on this index of growth (2, 8, 9, and 10). There are certain factors that complicate its use and may lead to error if they are not taken into consideration. For instance, the year a tree produces a large crop the growth is likely to be noticeably less than in a year of little or no fruit production. In some cases untreated trees may make a greater growth than those receiving a standard fertilizer treatment, when the fertilized ones are bearing

TABLE 3.—Summary of the Fertilizer Experiment, Comparing Twig Growth, Yield and Quality of Fruit, Ripening Date, Fruit Bud Formation, Set, and Hardiness

Plot	Treatment	Average twig growth (4 yrs.)	Average yield (3 yrs.)	Per cent of fancy and grade A A (3 yrs.)	Per cent of fruit harvested before Sept. 8, 1925	Per cent of fruit buds 1925	Per cent of fruit set 1926	Per cent of live buds 1927
		In.	*Lb.*					
1	Sulfate of ammonia, 3 lb. in April..................	13.1	1284	86	24	30	31	26
2	Sulfate of ammonia, 2 lb. in April and 1 lb. in June.	12.7	1366	83	20	38	....	47
3	Sulfate of ammonia, 1½ lb. in April and 2 lb. in June..	13.3	1215	81	32	26	34	37
4	Sulfate of ammonia, 2 lb. in April and 2 lb. in June.	13.3	1303	80	19	39	25	40
5	Nitrate of soda, 3.9 lb. in April....................	11.9	1370	75	16	37	30	39
6	Nitrate of soda, 1.9 lb. in April and 1.9 lb. in June..	13.3	1199	78	37	35	....	33
7	Nitrate of potash, 4.6 lb. in April..................	12.4	1414	77	15	37	37	37
8	Complete, 3 lb. sulfate, 4½ lb. P, 1½ lb. K, in April.	12.6	1363	76	36	43	28	37
9	3.9 lb. of nitrate of soda and 1½ lb. of muriate of potash in April.....	12.8	1160	81	25	34	26	56
10	7 lb. of tankage and 5 lb. of bone meal in spring.....	10.9	829	74	84	36	27	26
11	Check	7.3	471	76	91	12	13	16

a heavy crop, although this is not usual. Full response depends to a considerable degree, however, upon the native fertility of the soil. Also, peach trees growing in a very rich, black soil may make a vigorous growth and yet be unfruitful partly because of winter injury of the buds and partly because of a lack of fruit bud formation. As a rule, however, trees that consistently make a short terminal growth are relatively unproductive, and, within limits, the converse is true.

The trees in this experiment were injured somewhat by low temperature on several occasions; this reduced their vigor to some extent although the general appearance of the orchard was better than that of most others in the immediate vicinity. The injury was manifested by dead areas on the larger branches and in more dead twigs than usual. This injury is mentioned here, as it has some bearing upon length of twig growth, as well as upon yield, which is mentioned later. Furthermore, the age of the trees would account in part for the average length of twig growth, which, as is seen in Table 3, is not as great as would occur on younger trees. In 1924 the fruit crop was destroyed by a spring freeze and the growth of the trees was considerably greater than in the 3 succeeding years.

In considering the experiment by plots it will be seen that there is little difference in the first nine, all of which received the same total amount of nitrogen, with the exception of Plot 4, which received ½ pound more of sulfate of ammonia per tree in 1926. The average growth for the 3 years is from 12 to 14 inches in most cases, whether the nitrogen was put on in one or two applications in the spring or used with phosphorus and potassium.

It should be mentioned at this point that the system of applying half the nitrogen in April and the other half in June resulted in no noticeable effect upon the total tree growth or yield. One would gain the impression from frequent inspection of the orchard that this method was scarcely as effective as a single treatment. However, neither the growth index nor the yield data give clear evidence to support this observation. The complete fertilizer and the combinations of nitrogen and potash gave about the same general response in these experiments as did nitrogen alone.

Plot 10, which was treated with organic rather than inorganic fertilizers, showed a lower growth average than the other nine plots. The color and general appearance of the trees in this plot were continuously poorer than the color and appearance of those receiving inorganic nitrogen, and the yield was lower. The grass growth beneath the trees of Plot 10 was of a conspicuously soft, fine texture, differing from the coarse grass which developed from the use of inorganic nitrogen. So far as organic nitrogen is concerned, in this experiment it cannot approach the effectiveness of the inorganic forms and, as a rule, is more expensive.

We turn now to the plot which had been untreated since the beginning of the experiment but which prior to 1923 had received 3 pounds of sulfate of ammonia, as had the others. So far as growth is concerned, the contrast with the treated ones is striking (see Fig. 6). In 1926 this plot made as much growth as most of the treated ones, but the growing conditions were favorable and a very light crop was produced on the untreated trees as compared with the others. It is unlikely that there was any cross-feeding which would account for this improved growth, since all the fertilizer applied to the adjoin-

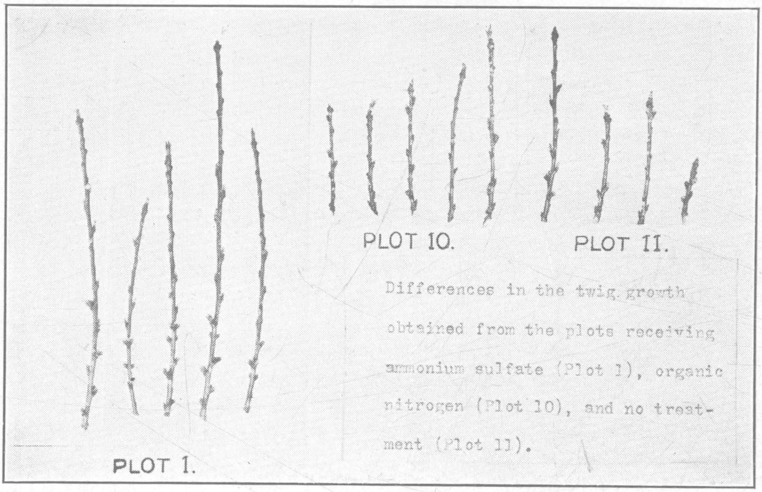

Fig. 6

ing rows was applied on the opposite side of the trees and in the tree row only. A comparison of the average growth of the first nine plots and Plot 11 is given in Table 4.

TABLE 4.—Average Twig Growth in Inches

	1924	1925	1926	1927	4-year average
Plots 1 to 9	20.8	10.8	8.9	10.6	12.8
Plot 11 (check)	7.1	5.8	9.6	6.6	7.3

This experience is in line with most peach fertilizer work and shows that readily available nitrogen is an important stimulus to tree growth and, as will be shown later, is of even greater value in producing high yields.

EFFECT ON FRUIT BUD FORMATION AND HARDINESS OF BUDS

It is impossible to say just how much effect nitrogen has on the hardiness of buds, because investigators do not necessarily take the same representative twigs from a tree for bud counts. It is well to remember that the first peach buds to start swelling in the spring are the most distal ones on each twig (probably closely associated with apical dominance). This has considerable bearing on the ultimate fate of the remaining buds on the branch. If these most distal ones survive, the flower buds lower down do not develop enough to produce fruit; but if they are killed, the more dormant buds may survive and produce a partial, fair, or, in unusual cases, even a full crop of peaches. This explains why so many orchards have had a crop of peaches following a sweeping statement that all the peach buds had been killed.

Fruit bud formation.—The fruit buds of the peach are formed laterally on the new growth; therefore, the length of the new growth will determine to some extent the number of fruit buds that can be formed. This factor is not so decisive as it first appears, for a short growth may have a larger proportion of fruit buds than a long one. Cooper and Wiggans (8) state that "as many fruit buds formed per unit of terminal growth on unfertilized as on fertilized trees"; whereas Alderman (1) states, "The nitrogen plots have produced an average of 76 per cent fruit buds each year against 60 per cent in the non-nitrogen plots". Crane (9), reporting later on the West Virginia experiments, stated: "None of the fertilizers had a marked effect on the per cent of fruit buds formed. The increased yield from nitrogen was due primarily to the larger bearing area as a result of greater growth, and possibly to a better set and smaller drop."

It is evident that the response has been somewhat different in the experiments quoted, and, as a matter of fact, in the present experiment there is a lack of consistency on this point; but evidently it is not uncommon for peach trees that are rather weak vegetatively to form abundant fruit buds. In such cases the set is usually very light unless the trees are treated with an early application of nitrogen.

In 1925 practically all the sample shoots used were the larger terminal ones. The unfertilized trees showed 12 per cent of the buds to be fruit buds, as compared with an average of 35.5 per cent from the 10 treated plots. In 1926 the check plots showed an average of 37.3 per cent of fruit buds from the terminal shoots, as compared with 39.8 per cent from the 10 treated plots.

In 1926 there was such a difference in the mortality of fruit buds on long shoots, short shoots, and very short spurs that separate counts were made of the fruit buds on them. The data for that year are given in Table 5.

TABLE 5.—Effect of Fertilizers on Fruit Bud Formation and Hardiness in Elberta Peaches in 1926*

Plot	Long shoots			2- to 4-inch spurs			Small clusters		
	Total buds (Av.)	Fruit buds (Av.)	Fruit buds alive (Av.)	Total buds (Av.)	Fruit buds (Av.)	Fruit buds alive (Av.)	Total buds (Av.)	Fruit buds (Av.)	Fruit buds alive (Av.)
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
1	30.5	10.0	2.2	6.1	2.3	1.3	3.8	2.8	1.3
2	16 4	5.5	2.6	6.1	2.3	1.6	3.7	1.9	1.5
3	19 6	7.0	2.7	7.4	2.1	1.8	4.0	1.7	1.6
4	21.1	8.0	2.9	7.3	1.9	0.9	4.1	1.8	1.1
5	22.3	9.6	3.3	7.9	2.6	1.4	3.9	1.8	1.1
6	24.4	9.8	2.4	8.0	2.4	1.1	3.6	1.6	1.1
7	19.9	8.0	2.3	9.8	3.2	0.9	4.4	1.0	1.6
8	20.9	7.3	2.3	8.5	2.6	1.1	3.4	2.0	1.5
9	19.2	4.3	2.2	11.8	2.6	1.6	4.6	0.9	0.4
Average	21.60	7.73	2.54	8.10	2.44	1.30	4.17	1.83	1.24
10	21.8	8.0	1.6	1.4	2 2	0.9	3.6	1.8	1.2
11	36.7	13.7	1.8	7.2	1.8	0.9	3.9	2.9	0.9

*Data taken in April, 1927.

The fact that the trees of the plots receiving nitrogen in the spring had many more shoots or potential bearing surfaces than the trees of the other plots would tend to increase the evidence in favor of nitrogen.

Hardiness.—That there is a difference in the hardiness of the fruit buds of the peach on different types of growth has long been observed. Fruit buds located along the more vigorous terminal shoots may be more easily killed than those on the short spurs on the older wood. As already indicated, this accounts in large part for the frequent errors in estimating the amount of damage to the fruit crop from bud injury. Much of the crop may be borne from buds that are largely ignored when an early spring examination is made.

Considering the literature in general, there is some evidence that the use of fertilizers will increase the hardiness of the buds. Chandler (6) applied 500 pounds of muriate of potash per acre to peach orchards in different locations in Missouri over a period of 4 years. There appeared no difference in the hardiness of the buds or of the blooms when spring frosts occurred. Cooper and Wiggans (8) report: "Fertilizer affected hardiness or resistance to frost only in that it retarded blooming. Late applications of nitrogen caused the tree to grow late into the season but the growth which was made after harvest was largely barren of fruit buds. This late growth did not, however, apparently make any difference in susceptibility of buds to frost injury." Although we do not have extensive observations on this point, our data indicate that trees which received no treatment were less hardy in the bud than those that received any kind or combination of fertilizer. Probably there is no wide margin of hardiness, but, in some seasons at least, there has been a measurable difference and benefit.[5] For example, Table 5 shows that it might be just enough to offset a frost and result in a partial crop at least.

INFLUENCE ON THE SET OF FRUIT

One of the striking effects of nitrogenous fertilizers upon fruit trees is the influence upon the set of fruit. This is often more evident when the nitrogen is first applied to weakened trees or those that have not been treated previously, as reported by Blake (5). A carefully checked observation was made of the trees in this experiment during the spring of 1926. One to three branches were selected in each plot at blossom time and the blossoms counted. A tag was tied to the limb to mark the point at which the observation was begun. After the fruit was two-thirds grown the number of fruits was counted and the percentage of set was calculated. Another observer made similar observations on other branches and the two results are averaged for an index of the percentage of set on the different plots. The fact that tags became detached from some of the trees accounts for a rather wide difference in the total number of blossoms counted and also for the omission of Plots 2 and 6 in the first observations. Table 6 gives a summary of these data.

It will be observed that the check plot (Plot 11) set 17 per cent of its bloom according to the first observer and 17 per cent for the second and that the sulfate of ammonia and nitrate of soda plots set 30 and 31 per cent, respectively. There were no significant differences among the other plots which were treated in the spring with an equivalent amount of nitrogen.

EFFECT ON TIME OF RIPENING

In numerous instances (8, 10, and 15) it has been reported that nitrogenous fertilizers delayed the ripening of peaches from a week to 10 days. In this experiment like results were obtained; the nitrogenous fertilizers were found

[5]Although not related to this experiment, some additional evidence may be cited from a commercial orchard at Ashland, Ohio. Some trees of Elberta peaches were not fertilized because the crop had been destroyed by a spring freeze; whereas the adjacent trees received their usual treatment of sulfate of ammonia. In April of the following year there appeared such a difference in the number of dead fruit buds on the untreated trees that an examination was made. Eighty-nine per cent of the fruit buds on the untreated trees was dead, as compared with 25 per cent on the treated ones. This extreme difference is not common but it shows that for the two orchards involved there has been a benefit to the hardiness of the fruit buds from nitrogenous fertilizers.

to delay ripening from 3 to 7 days, depending upon the treatment. Table 7 shows the period over which the peaches from the various plots ripened. It is to be noted that the largest percentage of the peaches harvested first was from the check and organic nitrogen plots; the nitrogen-alone blocks were the last to be harvested.

TABLE 6.—Influence of Fertilizers upon the Set of Fruit, 1926

Plot	First observer		Second observer		Per cent set, average of two observers
	Blossoms counted	Fruits set	Blossoms counted	Fruits set	
1	329	105	50	11	30
3	155	46	66	31	34
4	150	36	37	16	27
5	225	71	121	37	31
7	150	65	73	11	34
8	240	74	66	13	27
9	147	35	66	20	31
10	132	38	61	16	28
11	135	24	76	13	17

TABLE 7.—Effect of Fertilizers on Time of Ripening of Fruit

Plot	Per cent harvested at each picking								
	1925			1926			1927		
	1	2	3	1	2*	3*	1	2	3
1	24	48	28	9			27	29	34
2	20	39	41	14			32	25	43
3	32	40	28	1			32	42	26
4	19	54	27	1			31	28	41
5	16	84	0	16			14	57	29
6	37	63	0	16			28	58	14
7	15	85	0	11			19	64	17
8	36	64	0	7			5	78	17
9	25	75	0	24			26	51	23
Average	25	61	14	11			25	48	27
10	84	16	0	53			42	40	18
11	91	9	0	43			100†	0	0

*Data not available.
†32 per cent 4 days earlier; 68 per cent 2 days earlier.

EFFECT ON SIZE

Very misleading results may be obtained in a study of size in peaches if the factors concerned are not carefully taken into consideration. This is especially true when nitrogen is used in the fertilization of peaches. The fertilizer application may produce a growth status that will give both an overabundant bloom and fruit set with far too many fruits for the tree to bring through to maturity at 2 inches or more in diameter. Consequently, the practice of thinning comes into prominence in this phase of the experiment. Since no thinning was practiced in this particular setup, the data are lacking in that regard. When it is practiced, its cost should be added to that of the fertilization to be sure the results are comparable.

Table 8 is the summary for 3 years of the percentage of fruit falling in the Fancy and AA grades. The data are somewhat conflicting for the three seasons. In 1925 every plot receiving nitrogen in the spring, either as sulfate of ammonia or nitrate of soda in single or split applications, produced a higher percentage of the larger grades than the check plot or the one which received organic nitrogen. It is to be noted here also that the yield in these first nine plots was considerably greater than that in the other plots; when the percentage of high-grade fruit is also greater the argument for inorganic nitrogen becomes even more significant.

TABLE 8.—Effect of Nitrogen Fertilizers on Size of Fruit

Plot	Per cent of Fancy and AA Grades			Average of 3 years
	1925	1926	1927	
1	74	84	99	86
2	62	92	96	83
3	50	96	98	81
4	45	97	99	80
5	44	81	99	75
6	42	92	99	78
7	48	85	99	77
8	67	61	99	76
9	74	69	100	81
Average	56	84	99	80
10	29	94	98	74
11	41	95	93	76

In 1926 quite the opposite was true; the plots receiving inorganic nitrogen produced a lower percentage of the higher grade fruit than did the others. Here again the fact that more actual bushels of fruit were produced on the nitrogen plots must be considered. The same is true for the season of 1927, when there was little if any actual difference between plots in the percentage of the larger grades of fruit.

EFFECT ON COLOR AND APPEARANCE

Color of peaches is dependent, in part, upon the amount of sunlight reaching the fruit. Nitrogen fertilizer may increase the amount and density of foliage so that the fruit of a given variety is shaded more and consequently is less well colored. If fruit of trees receiving nitrogen fertilizer is left on the tree until of equal maturity with that of unfertilized trees, the color is usually satisfactory. In this experiment a complete fertilizer did not improve the fruit color. This is in line with the results of Cooper and Wiggans (8), who found that neither phosphorus nor potassium alone, together, or with nitrogen produced a significant increase in color of fruit.

EFFECT OF FERTILIZERS ON FIRMNESS AND SHIPPING QUALITY

Claims that the use of quickly available nitrogen fertilizer leads to the production of fruit of poorer keeping quality than the use of a complete fertilizer or no fertilizer cannot be established in these experiments.

The peach is admittedly a tender fruit and must be handled with great care if it is to reach the consumer in good condition. If, in commercial handling especially, the fruit is overripe when picked it is likely to soften and decay; if picked too green (which not infrequently happens), it is likely to shrivel somewhat or at least be of poor texture and low quality.

In New Jersey (18) fruit was picked from trees which were high in nitrogen (low carbohydrate) and from trees which were low in nitrogen (high carbohydrate). The trees which produced the former, designated for convenience as fruits N, had received applications of nitrogen fertilizer and were in a high state of vegetative vigor, with large, dark green leaves. The trees of the latter, fruits C, had received no nitrogen fertilizer for several years and were consequently much less vigorous in growth; the leaves were fewer and were small and yellowish. The purpose of the work was to study the problem of quality, development, and ripening of peach fruits as associated with the character of the growth of the tree itself rather than with the treatments given it. Softening of the fruits did not take place without a decrease in protopectin, cellulose, and thickness of cell walls. Fruits C became soft ripe (that is, they were in the best condition for eating) on August 31, 9 days before fruits N. Fruits C were a little firmer than fruits N. Fruits N as compared with fruits C were lower in reducing sugars, particularly sucrose, increased more in acidity during the period of softening off the tree when picked before the hard ripe stage, and were high in percentage and quality of nitrogen (simpler amino acid form for fruits N and complex protein-like form for fruits C). The fruits were not significantly different in tannin content when soft ripe, but, if a commercial picking of fruits N had been made on August 31, at the time of the last picking of fruits C, the peaches from the high-nitrogen trees would have been twice as high in tannin as the fruits borne on the high-carbohydrate tree and much more astringent in taste. The percentage of total ash was highest for fruits N and, as in the case of mineral elements, after the early stages of development.

In connection with these experiments, shipping tests were conducted on peaches (a) from an unfertilized lot; (b) from a lot rather heavily fertilized with nitrogen; and (c) from a lot that received a light application of manure. From the results of these tests it would seem, first, that the use of fertilizer, even in rather heavy applications, did not reduce the keeping and shipping quality of the peaches but within reasonable limits improved it; second, that the relative freedom from disease in the section was a natural advantage that might be capitalized; and third, that the summer spraying of peaches would appear to be an important factor in improving their carrying quality.

CONCLUSIONS FROM FERTILIZER EXPERIMENTS

1. There was no significant difference in the response of Elberta peach trees to inorganic nitrogen in the form of sulfate of ammonia or nitrate of soda, applied as a single application in April, one-half in April and the other half in June, or in combination with potassium and phosphorus (Plots 1 to 9).
2. Inorganic nitrogen was superior to organic nitrogen in both vegetative growth and yield.
3. The unfertilized plot had the shortest terminal (bearing surface) growth, with the exception of 1 year when it had a comparatively small crop and the fertilized plots produced a heavy crop.
4. The unfertilized plot produced less fruit than any fertilized plot.
5. Applications of nitrogen apparently had very little effect on the formation of fruit buds. However, it is conceivable that trees might be so low in vigor that they would fail to produce any fruit buds. In such cases nitrogen would effect fruit bud formation.

6. Nitrogen applied in the spring increases hardiness of fruit buds on the longer shoots (4 to 10 inches) but, from the results of this study, has no effect on the shorter shoots and spurs.

7. Application of nitrogen in any form or at any time increased the set of fruit.

8. Applications of inorganic nitrogen delayed ripening from 3 to 7 days.

9. Two out of 3 years organic nitrogen had little or no effect on time of ripening.

10. Nitrogen did not influence the size of peaches materially except in 1925, when percentage of crop alone is considered, but it did materially increase the actual number of bushels of peaches in the larger grades.

11. The application of inorganic nitrogen improved the keeping quality of peaches slightly over no treatment.

12. As a final conclusion, for the benefit of the commercial peach grower in Ohio, it is suggested that about ⅛ pound of sulfate of ammonia (or its equivalent) for each year of the tree's age be applied each spring. In addition to this, it is recommended that phosphorus and potassium be added between the tree rows where cover crops require them for satisfactory growth.

FALL FERTILIZATION

During the past few years there has been an innovation in the time of applying fertilizers to the orchard. Formerly, all applications of nitrogen fertilizers were made in the spring, about 3 weeks before bloom time; at present many growers apply them in the fall. Experimental evidence from several sources, as well as experience of growers, has shown that about equally good results can be secured from one as from the other.

There was apprehension at first that winter injury might follow fall treatments, but this does not appear to happen. One of the authors made fall and spring applications in two northern Ohio orchards for a period of 3 years; there was no evidence of increased winter injury from them even in a winter of low temperatures. The work was largely demonstrational and data are not available from it. Spring applications still prevail as the regular practice, but the time of application is earlier than formerly.

CYANAMID AS A CARRIER OF NITROGEN

Calcium cyanamide, which carries 21 per cent of nitrogen and 70 per cent of lime, is now commonly used for orchards in Ohio. It will be noted that the nitrogen content is about the same as that carried in sulfate of ammonia. When the material first came on the market it was somewhat objectionable to handle, but at present it is in a granular form and the former objection has disappeared.

Experiments with apple trees (21) have shown calcium cyanamide to be as satisfactory as the other carriers, and general orchard experience with peaches would suggest that the same holds true with this fruit. Occasionally, injury has been experienced on very light soils or from late spring applications.

The rate of application is ¼ pound for each year of the tree's age until 3 pounds per tree are used. However, in some types of soil an application of ⅓ pound for each year of the tree's age until 5 pounds have been applied has given satisfactory results.

PRUNING

THE ONE- AND TWO-YEAR-OLD TREE

The most common method of pruning the young tree as it is received from the nursery is as follows. The leader or trunk is headed back to about 24 inches in height. Four or five lateral branches which are well spaced between 12 to 14 inches from the ground and the top of the tree are selected. If there are no good laterals available all are removed and the tree is headed back to a whip of about 24 inches. New branches will develop during the growing season from which four or five may be selected as scaffolds the following spring.

Recent tests and observations indicate that the method outlined above is usually satisfactory but that the trees may well be headed back to 26 to 30 inches instead of to 24 inches.

THE MODIFIED DEBUDDING OR DESHOOTING SYSTEM

Another method which is being used to some extent is the modified debudding or deshooting system. As the peach trees arrive from the nursery there

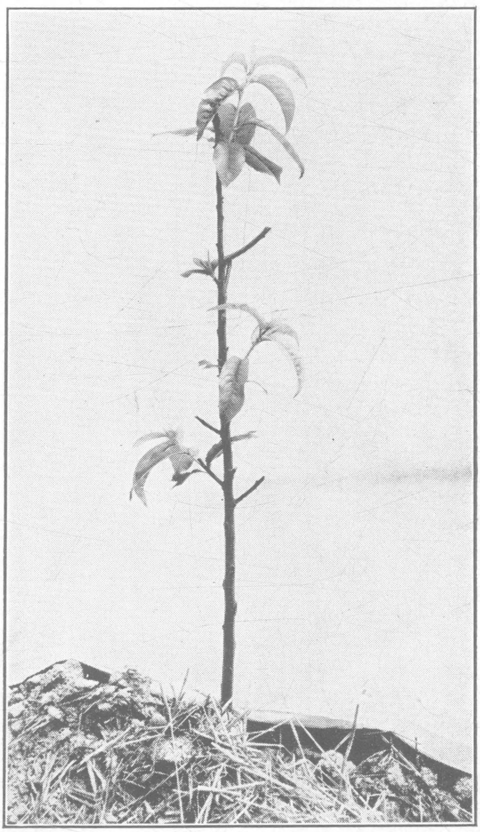

Fig. 7.—Young peach tree about 3 weeks after setting; pruned by debudding system. Note the four evenly spaced shoots.

are usually several branches a foot or more in length. These are headed back to stubs so that only one or two buds per stub are left. The tree is headed back to a height of about 40 inches (see Fig. 7). After the tree has grown 3 or 4 weeks and there are short shoots from the stubs, four or five shoots are selected for scaffold branches. These should be 6 to 8 inches apart and well distributed about the young tree; the lowest should be 14 to 16 inches from the ground. All the rest should be removed. Some pruning may be needed in the spring of the second season to remove any additional shoots. For the next 2 or 3 years little pruning is required; only some thinning out and heading back to outside laterals are necessary.

THE YOUNG BEARING TREE

Very little pruning is required during the first 2 or 3 fruiting years if correct training is obtained on the young tree, but occasionally a limb must be removed in order to maintain an open bowl-shaped tree. Older, more mature trees should be pruned relatively more heavily than young ones, though often too much wood is removed even from vigorous bearing trees. Experiments have shown definitely that it does not pay to "dehorn" or "dehead" the trees.

A pruning experiment in a young peach orchard (3 to 4 years old) on Catawba Island showed that heavy pruning reduced the yield materially in comparison with light pruning. The average weight of wood taken from the lightly pruned trees was 3 pounds, from the heavily pruned ones, 7 pounds. A summary of the results is given in Table 9.

TABLE 9.—Average Yield per Tree of Lightly Pruned and Heavily Pruned Trees

Method of pruning	First year	Second year
	Lb.	*Lb.*
Lightly pruned trees	40.0	40.1
Heavily pruned trees	30.8	22.2
Per cent of increase of lightly pruned trees	30.0	80.0

THE MATURE TREE

In pruning the mature bearing peach tree it is essential that the dead, injured, and weak branches be removed with enough of the others to permit the entrance of light and air into the tree. The type and length of growth made each year by the tree are the best guides for the grower in pruning.

RENEWAL PRUNING

Although there is an advantage in the light pruning of young peach trees, the mature peach tree requires more pruning than any other fruit tree; it may strictly be considered as a renewal system. Cullinan (11), in a report of some peach pruning investigations in Indiana, shows that "on properly trained trees, heavy renewal can be given by removing upright branches and by thinning shoots, without cutting back the main branches to upright stubs". Based on his experiments, as well as on others and on observations, it seems that the practice of heading back all branches is not advisable. In this publication (11) Dr. Cullinan also states that "trees trained by renewal-thinning are more open and the fruit is of better color".

By the use of this renewal method, trees may be kept at a height of 8 to 10 feet. At about this height the largest branch at each well-developed crotch is removed. This point at the crotch is used as a basis for the renewal height of the top. Two, or sometimes more, branches usually develop during the following year at this renewal point; the largest of these is removed at pruning. After several years it is necessary to change the renewal point. It may be selected slightly higher on the most vigorous branch, but more often it is preferable to lower it somewhat.

In a detailed study of "the fruiting habit of the peach as influenced by pruning practices" Marshall (16) presents data which show that the peach trees used in his study produced a satisfactory number of fruit buds regardless of the pruning treatments applied. These treatments included a wide range of systems and amounts of wood removal. Evidently, pruning methods in the peach orchard can be used, to a considerable degree, without direct consideration of fruit bud formation. Marshall's report indicates that winterkilling of peach buds was independent of the kind and length of wood produced by pruning. Investigations in Ohio indicate that winter injury is also independent of the type and length of growth produced by various fertilizer treatments. Further investigation of the relation between pruning and winter injury is necessary.

The bearing peach tree should be pruned every year. If one keeps in mind the position of the superior fruit of the previous season his pruning will be much better than otherwise.

The pruning of peach trees, especially in northern Ohio, should be done after the most severe winter temperatures are past; the pruning may then be modified with relation to crop prospects. The best time to prune a few trees is doubtless just after the fruit has set. Winter injury to twigs and branches is sometimes responsible for modifications in pruning practice. (This is discussed under winter injury).

REJUVENATION

Sometimes extra-heavy pruning is done on old or neglected trees to increase the amount of fruiting wood. It should not be done to compensate for the lack of adequate fertilization. It is known that heavy pruning sometimes increases the percentage of large-sized fruit, but it also greatly decreases the total yield. In some rejuvenation studies with peach trees in Maryland (19) several distinct methods were compared. These included "dehorning", moderately heavy pruning, light pruning, partial or gradual "dehorning", and no pruning. Moderate rejuvenation-pruning seemed most satisfactory. The data presented show that the moderately heavily pruned trees made the greatest total growth of new wood per limb and per tree during the two seasons following the treatment. These authors state that after this treatment "only a moderate type of thinning out and heading back was necessary on the trees at the end of the first season since a well-shaped spreading tree had been obtained. Likewise, in following years the tree required only a moderate pruning to maintain a well-shaped tree". This method is used in such a way that the trees are lowered so that orchard operations are greatly facilitated and a rapid rebuilding of adequate fruiting wood results.

The strength and permanence of the tree, as well as the fruit production each year, must be kept in mind. It has been found that by careful pruning to vigorous laterals, the spread of the tree can be well controlled. Well-spaced fruiting wood and the maintenance of an open type of tree are especially desirable. The system outlined for the renewal of tops is not so well adapted to the inside of the tree or to controlling its spread. These are accomplished mainly by thinning out and heading back to vigorous laterals.

Although correct pruning will reduce the amount of thinning, propping, and bracing necessary, it will not eliminate them in years of heavy crops.

A further discussion of pruning is given by Beach in Extension Bulletin No. 145, Ohio State University.

THINNING THE FRUIT

The practice of thinning peaches, especially during years of heavy crops, has been definitely established. The distance to which the fruit is thinned on the branches depends somewhat on the size of the mature fruit of the variety. In general, the smaller the normal size of the mature fruit, the greater the distance to which it should be thinned. The exact thinning distance depends also on the leaf surface per fruit and the general vigor of the tree. Thinning should usually be to a distance of 6 to 7 inches, measured along the twigs. Although this may seem to be a rather drastic treatment, as well as an expensive one, it must be remembered that the market is most critical when a heavy crop is produced. Also, peaches of the most desirable sizes and of the best quality can be sold most satisfactorily. Thinning lessens the labor of harvesting the crop and decreases the danger of limb breakage from weight of fruit.

Tests of time of thinning peaches are not entirely consistent. Investigators in West Virginia (13) and Illinois (12) have reported no significant advantage in early thinning (before the June drop). Since much less fruit is removed when the thinning is done after most of the drop is over, the actual process of thinning is less expensive. Furthermore, any fruit which is blemished or damaged by insects may be removed by late thinning. Some experiments conducted in Ohio in 1931 and 1932 (20) showed advantages in early thinning. These consisted in larger sized fruit and higher yields, especially during the year following the early thinning treatment. It seems that the trees which were thinned before the June drop were in better condition for a crop the succeeding year than those thinned late. It appears likely that when heavy crops are produced continuously for several years early thinning is preferable. However, data secured from the Station Elberta orchard in the early spring of 1936 showed no relationship between the thinning treatment of the previous season and the number of fruit buds in proportion to leaf buds produced that year. The trees from which these data were taken included those thinned early (before the June drop) to distances of 4, 6, and 8 inches and those thinned late (just after the June drop) also using the 4-, 6-, and 8-inch thinning distances.

It is well known that in years of a full crop there is much variation in size of the fruits just before the June drop (see Fig. 8). Owing, apparently, to competition between the fruits, many of the smaller ones drop during this period. The larger ones are probably advantageously situated from a physiological standpoint.

Results of investigations on Elberta at Wooster in 1935 indicated that it is possible, by thinning to 8 inches just after bloom, to prevent almost entirely both the variation in size and the dropping of the remaining fruit. It is not meant to imply that this time of thinning is economical or practical, although it is beginning to be practiced in a few sections where some of the largest peach growers believe it to be worthwhile.

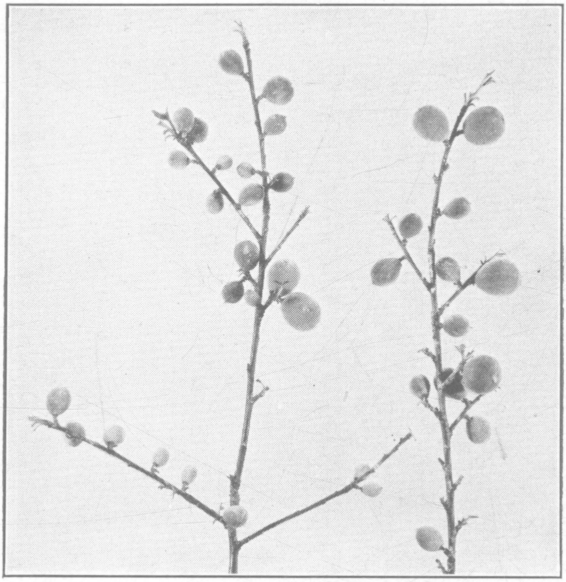

Fig. 8.—Variation in size of fruit just before the June drop. The smaller ones will drop regardless of thinning treatment at this time.

WINTER INJURY

Winter injury is one of the most important factors in peach growing in Ohio. Almost every winter the peach trees are at least slightly injured by low temperatures. Although often the injury is not serious, sometimes not only the fruit buds but the trees as a whole are severely injured or killed, as during the winters of 1917-1918 and 1935-1936. The most usual types of winter injury are injury to fruit buds; injury to twigs, branches, and trunk; and injury to roots.

BUD INJURY

Leaf buds are not, as a rule, injured during the winter unless the entire twig is killed. The most common form of winter injury to peaches in Ohio is the destruction of the fruit buds. The temperature at which the fruit buds are destroyed depends on several factors. Among these are the condition of the previous growing season, age and vigor of the tree, variety, stage in fruit bud development, maturity of buds and tree, and time of occurrence, rapidity of the drop, and duration of the low temperature. No definite minimum temperature can be given even for one variety; however, during midwinter the danger point for Elberta is about —10° F. to —12° F. No doubt, the rapid drop in temperature during the few hours before the minimum was reached on January 22, 1936, caused more injury than would otherwise have occurred in Ohio. Furthermore, the high winds, as well as the duration of the low temperature, during that winter doubtless resulted in increased damage.

As indicated in Table 2 some of the varieties with the most tender fruit buds are Elberta, J. H. Hale, and Wilma. The fruit buds of Carman, Belle of Georgia, and Golden Jubilee are more hardy; whereas those of Rochester, Greensboro, and Eclipse are among the most hardy relative to low temperature. In addition to the yield data given in the table it would have been valuable to have recorded the percentage of fruit buds killed each year in order to measure the relative hardiness of the varieties more satisfactorily.

Certain investigations pertaining to bud hardiness were carried on in Illinois (17) in an orchard which showed marked responses to fertilizers as far as shoot growth, leaf size, and color were concerned. It is stated that "even the higher applications of nitrate of soda or ammonium sulfate, however, did not increase or decrease the hardiness of the buds as compared to plots receiving lesser amounts or to the check plot. Neither did 'splitting' the applications seem to have any influence in producing hardier fruit buds." However, it is a common observation that weak trees suffer most during severe winters.

Occasionally, there is considerable damage to the fruit at or near the blossoming period. Much higher temperature will cause severe damage at this period than earlier. The minimum temperature that peaches will withstand at full bloom is about 25° F. Just before the flowers open they will survive about 20° F. to 23° F.

INJURY TO TWIGS AND BRANCHES

No doubt the cause of most of the killing of small twigs throughout the trees almost every winter is associated with lack of maturity. However, many twigs and even well-matured branches may be killed back during winters of extremely low temperatures (—15° F. to —20° F.). Branches will survive much lower temperatures if the temperature drops slowly than if there is a rapid fall.

The severe winter of 1935-1936 offered an unusual opportunity in Ohio to study certain factors associated with winter injury. Many of the factors were so interrelated that it was impossible to separate them. In some sections all peach trees were killed. About 75 per cent of the mature ones in Ohio south of Columbus was destroyed (Fig. 9). Probably 40 to 50 per cent of those over

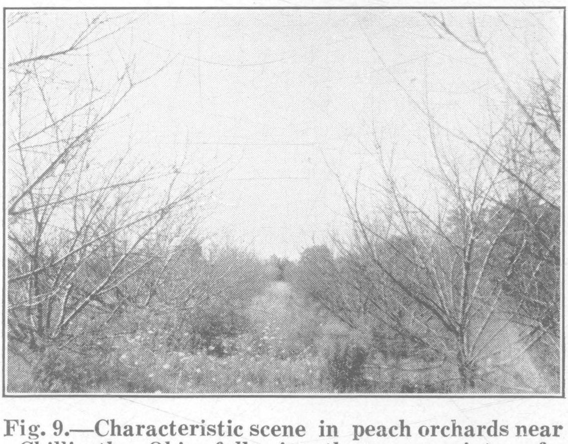

Fig. 9.—Characteristic scene in peach orchards near Chillicothe, Ohio, following the severe winter of 1935-1936. Photographed July 20, 1936

10 years of age north of Columbus was also killed. The minimum official temperatures occurred during January 22 to 24, varying from —30° F. at McArthur to —10° F. at Cleveland. In a few exceptionally well-protected locations near the Lake they were hardly as low as those recorded at Cleveland.

In most cases the younger trees were injured least, but in a few regions in the State the reverse was true.

Where differences could be observed the most injury to peach trees was usually found in trees of low vitality resulting from such conditions as poor drainage, low soil fertility, heavy fruit production in 1935, previous injury (from drouth, borers, or winter injury), and/or very old age.

There were also regions where immaturity of wood was a very important factor. Killing due to this occurred to branches as well as to entire trees, probably as a result of very vigorous growth in 1935 and/or an early frost in October. In a few regions, especially in Sandusky County, many trees were partly killed; yet the branches which were not entirely dead bore blossoms, and those in better condition bore a crop of fruit (Fig. 10). This condition is rather unusual, but shows that under certain conditions fruit buds may withstand a more severe winter than the trunk and branches.

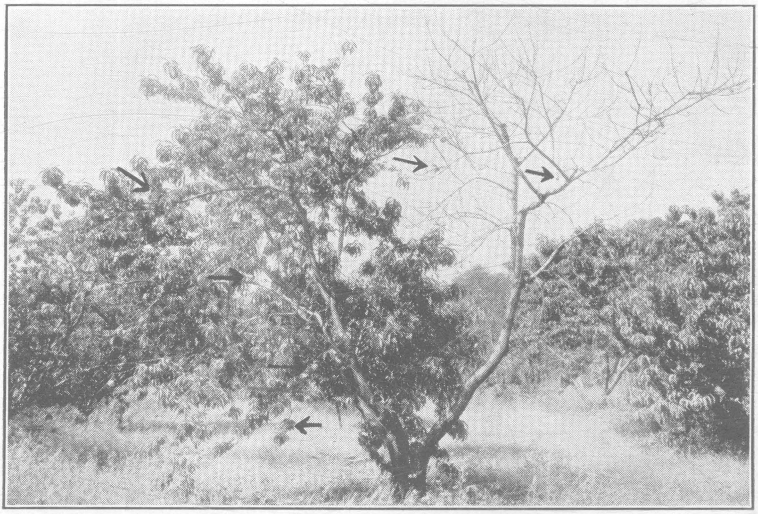

Fig. 10.—Results of winter injury (1935-1936) of Elberta peaches near Clyde, Ohio. Note fruit (indicated by arrows) on injured tree; this shows a somewhat unusual relationship between the hardiness of the buds and the wood.

When there is considerable damage to the wood, the trees should not be pruned until late in the spring; after growth starts is probably the most satisfactory time. Moderate rather than heavy pruning should then be practiced. The branches which are completely dead may be removed and the tree given a detailed pruning treatment.

Even though the wood may seem to be severely damaged following an extremely cold winter, much of it may survive if the trees are not pruned too heavily and if a somewhat heavier application of quickly available nitrogen than is usually used is applied. A variety which has tender fruit buds may have relatively more hardy wood; this is the case with the Elberta. When there is severe damage to large branches or trunks the injured portion should be painted with a standard tree paint, white lead and raw linseed oil, or a liquid (brush) grafting wax. If the bark is loosened following severe temperatures, it should be tacked back into place immediately, as this aids in preventing drying out of the bark and wood and may facilitate healing.

INJURY TO ROOTS

Injury to peach roots from cold is too often disregarded. More injury than is realized may occur in this portion of the tree. Winter injury to roots is usually most severe in light, sandy soils. It is much worse when there is no snow or other covering on the ground. Cover crops are valuable in preventing winter injury to roots. In addition to their direct insulating effect, cover crops aid in holding the snow. Following severe killing of the roots the tree should be given a moderately heavy pruning; it will then be more likely to recover.

In some instances, although the roots are not killed, the ground is frozen to such an extent that water absorption is retarded. Trees grown in light, shallow soils are, of course, more likely to be injured as a result of this condition.

HARVESTING AND MARKETING

TIME OF PICKING

A great deal of experience is necessary to enable the grower to determine the exact stage at which peaches should be picked. The degree of maturity to which the fruit is allowed to develop depends largely on the marketing method. To permit the development of the highest color and sugar content and the largest size, peaches should be left on the tree as long as possible. Experiments have shown that color and pressure tests are the most reliable indexes of maturity. These, however, vary somewhat with the variety, which makes it extremely difficult to set up a definite guide. The ease with which the fruit separates from the stem should not be used as a guide to maturity. It varies with the previous growing conditions of the season, as well as with the variety. If the fruit is to be run over a sizing machine it must be picked earlier than would otherwise be necessary. In order to permit the fruit to become as ripe as possible before picking, it is quite often necessary to pick from each tree two or sometimes three times during the season. This process is, of course, not economical when there is a very light crop.

HANDLING THE FRUIT

Care should be taken not to bruise the fruit in handling. Pickers should not press the fruit. The container commonly used in picking is the 16-quart or ½-bushel basket. Galvanized pails are sometimes used, but they tend to bruise the fruit more than the baskets. Picking baskets lined with corrugated paper have been used successfully in some sections. Each process in the grading of the fruit, whether done by hand or machine, should be watched carefully, and care should be taken to avoid excessive and rough handling. The fruit breaks down much more quickly where there are even slight bruises and when there is much delay between picking and marketing or storage.

STORAGE

Some Canadian investigators reported recently that the most satisfactory temperature at which to store peaches is about 32° F. At this temperature, firm, ripe Elbertas kept only 10 to 14 days in good condition. Of course, peaches picked at an earlier stage will withstand much longer shipment than those picked when ripe, but the highest quality must be sacrificed if the fruit is picked at an immature stage. After the fruit is removed from storage it breaks down very rapidly. There is considerable difference in the keeping quality of the various varieties. The Hale is well known as a good keeper; whereas Hope Farm and Rochester are poor keepers.

MARKETING

Several years ago there was a good market in Ohio for peaches to be used for home canning. Recently, however, there has been a decided trend away from home canning. This has changed the marketing situation somewhat, especially in certain sections of the State, but much of the fruit is still sold locally and probably this will continue.

Trucks and good roads have made it possible to transport peaches quickly from the orchard to a central marketing place. Therefore the consumer can secure fruit of much higher quality than formerly.

It seems that the consumption of early peaches and white peaches should be encouraged in Ohio. The development of attractive roadside markets and the sale of high-quality fruit at local retail stores will be helpful in this. Yellow freestones from the southern states compete strongly with the early market, but there has been a continual improvement in early peach varieties in Ohio, and this is likely to continue rapidly during the next few years.

In order to secure the greatest return in marketing, peaches must be of high quality and uniform size. Size and quality are most important in years of heavy crops. The peaches should be set up in an attractive manner. This is especially important when they are sold at a roadside stand or on the farm.

It is highly important that the grower who markets his fruit through a roadside stand have carefully selected varieties which ripen during the entire season. With the large number of varieties now available, it is possible for the grower to do this. Advertising the sale of the peaches by means of local newspapers, printed circulars, and roadside signs is many times helpful in disposing of them profitably.

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